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ABSTRACT

This survey of current provincial elementary school mathematics curricula as perceived by ministries of education, school and teacher education personnel was undertaken to attempt to identify common priorities in programs. As the survey progressed it became evident that within the provincial arena, stated objectives did not necessarily represent actual practice. But in spite of the vertically structured educational scene in Canada and a wide diversity of student, teacher, and institutional goals and capabilities, certain "national trends" often expressed as needs or concerns can be identified. This report presents these findings. (Author/MK)

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ELEMENTARY SCHOOL MATHEMATICS IN CANADA

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The Nature of Provincial Elementary Mathematics Curricula as Perceived by Ministries of Education, School and Teacher Personnel

by

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January 1980

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PREFACE

The topic "School Mathematics in Canada" can be approached from many different perspectives and contexts. An overview and analysis of objectives related to current practices and attainments may interest some, while developmental, psychological and societal elements may concern others. Each and all of these aspects could be studied at the elementary or secondary level in a district, provincial, regional or national area.

However, this particular survey of "current provincial elementary school mathematics curricula as perceived by ministries of education, school and teacher education personnel" was undertaken to attempt to identify common priorities in programs. As the survey progressed it became evident that within the provincial arena stated objectives did not necessarily represent actual practice. But in spite of the vertically structured educational scene in Canada with wide diversity of student, teacher and institutional goals and capabilities, certain "national trends" often expressed as needs or concerns can be identified. This report will present these findings.

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INTRODUCTION

Elementary school mathematics has been subjected to public and professional criticism over the past decades. The attack has been focused on two major curriculum reform movements, commonly referred to as the 'meaningful arithmetic' which began in the 1930's and extended into the 50's and the 'modern mathematics' beginning in the late 50's and extending into the early 70's. Professional challenges have come from mathematicians, psychologists and educators - concerned with sequence, structure and teaching styles while public critics have focused on issues of content and curriculum priority - reporting declining math scores and advocating a return to the basics.

Briefly, a review of the literature of recent developments in mathematics curriculum suggests that the forces influencing it represent the subject, the society and the child. During the past twenty-five years the subject of mathematics as conceived and represented by mathematicians was the primary influence on the direction of change. But strong reaction has resulted in a thrust to devise a more effective curriculum to prepare the child of today for the mathematical needs of tomorrow. Concern over appropriate content with emphasis on computational skills or applications is paralleled by an equally spirited debate over instructional practice. Curriculum developers have been confronted with a wide range of competing theories of methodology, motivation, classroom organization and cognitive development. Similarly, management concepts of performance objectives and the impact of such technological changes as calculators have added other dimensions of uncertainty. The basic question of mathematical literacy is now focusing widespread attention on proper goals and achievement in elementary school mathematics.

PART 1. THE STUDY

What is the nature of the provincial elementary mathematics curricula as perceived by ministries of education, school and teacher education personnel?

Implicit in this statement of the study are the following questions:

A. What are the objectives as stated in provincial guidelines?

B. Are these objectives reflected in current school programs and classrooms?

C. What are the common concerns regarding the status of elementary mathematics?

D. What are the apparent trends in Canadian elementary school mathematics?

1.1 Methodology

A preliminary investigation of curricular guidelines was made by my examining materials available in the offices of the Council of Ministers of Education of Canada, Canadian Education Association, Ontario Institute of Studies in Education Curriculum Library, University of Toronto's Faculty of Education Curriculum Library, and through ERIC and ONTERIS searches.

Individual letters were sent to each of the ten provincial ministries of education and to twenty university faculties of education. Information regarding provincial guidelines, support documents, university programs for the preparation of elementary teachers and suggestions for school visits were requested and received.

Based upon the responses, I scheduled a series of interviews in all ten provinces over a ten month period. A total of 111 interviews were distributed as follows: ministry personnel - 26, school personnel - 41, teacher education personnel - 44. In addition visits were made to 16 classrooms.

Additional information was obtained from my attendance at conferences including the National Council of Teachers of Mathematics in Boston, Ontario Association of Mathematics Education in Peterborough and Canadian Mathematics Education Study Group in Kingston.

When I had compiled and analysed the curricular guidelines on a provincial and national basis, I then identified the priorities and formulated my observations.

1.2 Limitations of the Study

The response to the initial letters and requests for interviews was extremely positive. Respondents were asked to react freely, in an unstructured interview, to certain questions or ideas related to mathematics curriculum. Through this procedure involving judgments, reactions and observations, a number of issues were raised and concerns revealed. But in spite of the direct information obtained from official guidelines and from the impressions formed from the variety of interviews, interpretation of the analyses and observations warrants caution.

PART 2. PERCEPTIONS OF ELEMENTARY SCHOOL MATHEMATICS

Since the responsibility for education in Canada is a provincial matter, each province has its own administrative structure, sets its own standards for entry and graduation, and determines its own qualifications for teaching certification. This results in great diversity of organization, policy and practice. Added to this complex structure is the wide range in student and teacher populations and capabilities - important factors in such areas as program development, implementations and assessment. The impact of this vertically structured scene will be highlighted in the report based upon the data collected from ministries of education, school and teacher education personnel.

2.1 Ministries of Education (or Departments)

Questions

During interviews with a representative of each ministry (either a Mathematics Coordinator or Consultant, Director or Associate Director of Curriculum, or Curriculum Consultant) questions were raised concerning:

A. Teacher-student populations.

B. Role and policies of the ministry regarding provincial guidelines, program development and assessment, in-service education and special services.

C. Needs and problems in mathematics education.

D. Current trends.

Responses

A. Teacher-Student Populations

Enrolments as reported by Statistics Canada[1] for the year 1977-78 for the Elementary level I-VI and Special classes:

	Student Population	Teacher Population
	(approximate figures)	
NEWFOUNDLAND	81 300	4 900
PRINCE EDWARD ISLAND	14 000	800
NOVA SCOTIA	89 600	6 400
NEW BRUNSWICK	78 500	4 300
QUEBEC	595 900	34 500
ONTARIO	835 100	54 600
MANITOBA	100 100	6 600
SASKATCHEWAN	97 600	6 100
ALBERTA	203 800	12 600
BRITISH COLUMBIA	232 000	13 200

B. Role and Policies of the Ministry Regarding Provincial Guidelines, Program Development and Assessment, In-service Education and Special Services

In response to a question regarding the role of the ministry, all provinces named program development, revision and implementation as their major responsibility. A second priority considered by many was "in-service education" in varying stages of development. "Special

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[1] Statistics Canada: Elementary - secondary school enrolment, 1977-78, p. 48.

———————: Salaries and qualifications of teachers, 1977-78, pp. 30-31.

services" was mentioned by a number of respondents. Major assessment studies have been undertaken in four provinces (B.C., Alta., N.B., N.S.). "Planning and research" projects were cited as major commitments in two cases (Alta., Ont.). Publications other than curriculum guides and support documents were considered as a minor priority.

To attempt to describe in detail the organization of the ministries with respect to the development and implementation of programs would be difficult from the information obtained. Ten different structures can be placed on a continuum ranging from a highly centralized organization where the main authority is administered in the government offices and a serious effort is made to monitor all areas in the province, to a decentralized organization where general guidelines are drawn up for local regions to implement.

The procedure followed in curriculum development is similar in all provinces. A ministry curriculum or mathematics consultant and a coordinating or advisory committee or task force are responsible for developing guidelines. The committee is appointed by either the ministry or provincial associations. Six provinces have revised their programs during the past four years. Four reported at the time of the interview that revisions were in progress (Sask., Que., Nfld., N.B.). Provincial curricula will be discussed in a subsequent section.

Implementation of programs was considered a major problem in many provinces. Successful efforts were noted in Manitoba, Nova Scotia, Prince Edward Island, Newfoundland, where workshop sessions were sponsored by the ministry. But most consultants felt restricted by

time and funds available. In Manitoba a yearly conference held early in the fall provided the opportunity for the ministry in cooperation with provincial associations to launch the revised program. This was followed by sessions led by a field service consultant in numerous areas of the province. Another service provided was a specially prepared videotape further explaining the program.

C. Needs and Problems in Mathematics Education

When asked to identify specific problem areas, all provincial consultants emphasized their concern for the financial constraints in program implementation. A need was felt for additional personnel to assist in the development of district or local programs, and to provide leadership in assessment studies and program innovations.

In-service education was cited as a major need in most provinces, but there was a difference of opinion regarding the role of the ministry. It was generally considered that the responsibility shared cooperatively by the ministry, school and university personnel would provide most effective results. But in most instances this procedure is not workable. District boards of education, provincial associations and faculties of education have initiated programs which have supplemented ministry offerings in most provinces. Many provincial consultants stressed the need for improved initial teacher preparation in such areas as Basics, Learning Problems, and Evaluation.

A topic causing general concern is assessment. When questions were raised regarding purposes, procedures and impact no simple or clear trends emerged. As mentioned previously, major assessment studies have been conducted in four provinces and others are

considering similar action. However, the emphasis in some reports did not appear to be clearly defined, as evidenced by such stated objectives as "the measurement of student performance" or "program evaluation".

Lack of communication was cited as an ever-increasing problem. Improved means of disseminating information re program innovations, classroom practice and research activities are needed between ministry offices, school boards and universities - within provinces. But there appeared to be little knowledge of or concern for what was happening on the national scene.

D. Current Program Trends

When identifying trends in current school programs, equal emphasis was placed on content and instructional practice. Specifically, changes in content focus mainly on 'Basics' which appear to be interpreted as computational skills, and inclusion of topics such as problem solving, geometry, measurement and graphing. Trends in instructional practice point to increased usage of manipulative materials and tests, and minimal reliance on a single text. The discrepancy between actual school practice and program requirements is noticeable.

In response to a question regarding the use of calculators, six of the provincial consultants replied that no definite policy had been adopted while two (B.C., Man.) favour postponement of use until post-elementary years. Two other provinces (Que., N.S.) are presently considering the topic.

With reference to provincial curricula in elementary mathematics, a survey indicates a wide variety in organizational style, specificity, grade level focus and content. Samples of these are included in Appendix B.

2.2 Provincial Positions on Elementary Mathematics

NEWFOUNDLAND
(Program under review)

Aims and Objectives of Elementary Mathematics[1]

Some of the major cognitive goals are:

1. The identification and use of the basic properties and operations of the real number system.
2. The identification and knowledge of the properties of basic geometric shapes.
3. The understanding and application of various measurement related concepts.
4. The transformation of data into graphical representation and interpreting the meaning of the data.
5. The ability to use the skills of problem solving to solve problems arising from physical or environmental situations.

PRINCE EDWARD ISLAND

Mathematics: Authorized Program[2]

Years I - III	Series Mathematics (Collier-MacMillan).
Years IV - VI	It is anticipated that a new authorization will replace Elementary School Mathematics (Addison-Wesley) in the fall of 1979.

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[1] Programme of Studies, 1978-79.

Mathematics Curriculum Guide Committee Report, 1979-09-27

[2] A Style for Every Child, 1977-78

Amendments: 1978, p. 5.

NOVA SCOTIA

General Aims of the Elementary Mathematics Program[1]

1. To provide opportunities to discover the order, relationships and patterns that are the basis of mathematics.
2. To develop the ability to describe, record and extend these patterns.
3. To provide opportunities to acquire the basic mathematical skills including facility with both numerical and quantity relationships.
4. To develop the ability to relate a situation or event that occurs in daily life to a mathematical representation.
5. To develop the ability to solve problems.
6. To develop attitudes of self-confidence in the child's ability to use mathematics to better cope with the world.

NEW BRUNSWICK
(Program under review)

Mathematics[2]

Introduction

Mathematical knowledge, especially at the elementary school level, should not be aimed directly at producing future mathematicians, rather at developing students who, presented with new concepts, will recall and use previous learning.

It is quite possible that by the time the students in today's elementary school are employed they will need skills that are not known today. Hence, a mathematics program that stresses the acquisition of skills through rote learning and not through meaningful understanding is not satisfactory. A student needs to understand the principles that

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[1] Public School Programs, 1978-79.

Mathematics: Primary-Six, 1977, p. 1.

[2] Handbook for Elementary Schools, 1977-78, p. 24.

govern the structure of our numeration system, needs to develop his own generalizations in order to adjust to new situations, to acquire computational skills and to use this knowledge effectively in a scientific and technological society. . .

QUEBEC
(Program under review)

French - Objectifs mathématiques du programme-cadre[1]

a. L'exploration ou l'apprentissage de concepts, propriétés, relations, régularités ou structures mathématiques.

b. Une familiarisation progressive avec certains éléments (verbaux, graphiques, symboliques) du langage mathématique, nécessaires ou utiles pour la communication.

c. La mise au point, l'entretien et, dans certains cas, l'automatisation d'un certain nombre d'habilités ou de techniques.

d. Le développement d'attitudes positives vis-à-vis de la mathématique et de son rôle dans la société.

English - Specific Objectives

a. To cover basic numerical concepts and operations.

b. To foster comprehension of the principles of numeration.

c. To help pupils master fundamental algorithms of elementary arithmetic.

d. To introduce the basic geometrical concepts related to physical space.

e. To develop the ability to express a problem in mathematical terms and solve it by appropriate means.

f. To provide an insight into mathematical structures.

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[1] Programme-cadre: La mathématique à la classe maternelle et au niveau élémentaire, 1976, pp. 7-8.

Elémentaire mathématiques: Programme-cadre, 1973, p. 1.

ONTARIO

Mathematics[1]

Mathematics is an invention of man that helps us to understand, analyse, and communicate both qualitative and quantitative ideas about our environment. Fundamentally, it consists of abstract models that represent aspects of the real world, as well as rules and operations for working with these models.

The process of mathematics consists of choosing or creating models; of studying, analysing, and manipulating them, and of relating the findings back to the real world. The diagrams of geometry, the numerals and operations of arithmetic, the graphs and charts representing data and relationships are all models that children employ in their daily activities. These models help children to see relationship in the environment and thus to make sense of the world about them. . . .

Learning experiences will enable the child to:

1. Understand and use numbers and operations.
2. Use measurement in relevant situations with an understanding of the concepts involved.
3. Understand relationships involving space and shape.

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[1] Formative Years, 1975, pp. 6-7.

Education in the Primary and Junior Divisions, 1975, p. 61.

MANITOBA

Specific Objectives of the Mathematics Program[1]

1. To provide experiences which will lead to increased understanding, knowledge and skills in numbers and operations appropriate to the needs and capabilities of children.

2. To develop an understanding of the structure of the number system and its applications.

3. To develop an understanding and mastery of the skills of computation.

4. To develop an understanding and facility with measurement including estimating, approximating, and verifying through use of appropriate measuring instruments. These concepts are important mathematical tools.

5. To teach children to observe, identify and be aware of geometrical relationships involving space and shape.

6. To diagnose weaknesses on an ongoing basis and provide appropriate remediation related to practical, everyday situations.

7. To provide opportunities to increase understanding of problem solving, ethical thinking, and methods of inquiry and discovery in math.

8. To encourage children to observe, collect, interpret and display data in simple graphs as a part of their communication skills.

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[1] Mathematics K-6, 1978, p. 14.

SASKATCHEWAN
(Program under review)

Divisions I and II Elementary Mathematics Program[1]

Rationale

. . . Appreciation of Mathematics must be a major consideration when formulating a new program. . . .

The mathematics program for students in Divisions I and II must be vital, positive, and dynamic in that it meets the needs and capabilities of all students. To reach this objective, it is above all a program in which the students are led to think in mathematical terms and to discover for themselves mathematical principles or generalizations. It is essential that the program contain math that is significant and interesting to the student but still remain useful in the work at hand and as a preparation to further study. Such a program as pictured is likely to produce students who will be able to cope with some of the problems of the future.

ALBERTA

Goals of Elementary School Mathematics[2]

The goals of elementary school mathematics are to develop within the student the competency and willingness to deal with or interpret his environment:

- by giving the individual the opportunity to discover order, pattern and relations which are the basis of mathematics found in the natural world and,
- by giving the individual proficiency in skills necessary for daily living.

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[1] Mathematics Curriculum Guide, Divisions I and II, 1977, p. 2.

[2] Program of Studies for Elementary School, 1978.

Elementary Mathematics - Curriculum Guide, 1977.

The general objectives of the elementary school mathematics program are of two related types, those dealing with the learner and those dealing with mathematic content.

A. The program should foster within the learner:

   a. a sense of accomplishment and success with math which should lead to positive self-concepts, and,

   b. a positive attitude towards mathematics.

B. The program should provide the capacity to cope with the environment through the development of process skills:

   a. communicating the receiving of math - data and expressing results in such a way that others understand.

   b. decision making - being able to define a problem, produce hypotheses about it and plan strategies to test these hypotheses.

   c. organizing the collection of information and sorting it into meaningful units which fit previous organizations and allow for the addition of future elements.

   d. creating, starting with an idea and following it through to a product.

C. The program should provide for the development of an understanding of numbers, operations and priorities, measurement, geometry, and graphing through:

   a. mathematical literacy - receiving, understanding and using terms and symbols.

   b. arithmetic skills - the ability to recall basic facts and to compute.

   c. application - the ability to apply appropriate method and content to solve problems.

BRITISH COLUMBIA

In identifying the major goals of a mathematics program, one must consider that the broad goals of math are derived from the needs of individuals and of society. The practical usefulness of math in our scientific and technological society is increasingly apparent.[1] . . .

Major cognitive goals: The mathematics program will enable the student:

1. To identify and use the basic properties and operations of the real number system.
2. To identify common geometric figures and demonstrate a knowledge of their basic properties.
3. To transform given numerical and algebraic expressions into equivalent expressions.
4. To solve open sentences of various types and degrees of complexity.
5. To apply knowledge of mathematics to familiar physical or environmental situations in order to construct a description mathematical model of the situation or to solve a problem arising from the situation.

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[1] Guide to the Core Curriculum, 1977.

Mathematics Curriculum Guide, Years 1-2, 1978, p. 6.

2.3 Summary

To illustrate the great diversity among the stated objectives two examples can be cited:

A. a single reference to a text series as being the authorized program, and

B. a very broad statement of the need for students to see relationships in the environment and thus to make sense of the world about them.

In spite of the diversity, some general emphases can be identified:

A. The development of an understanding of:

- numbers, operations and properties
- geometry
- measurement
- graphing
- applications of mathematics.

B. The development of skills in:

- computation
- problem solving
- communication.

C. Goals in the affective domain of development:

- positive self-concepts
- positive attitudes towards mathematics.

An examination of the content included in provincial curricula reveals a similar diversity in organizational style. The range of variety includes:

- specific performance objectives - or learning outcomes
- topic lists arranged by grade levels
- scope and sequence charts arranged into content strands
- learning experiences.

Predictably, even with the variety, topics common to most programs can be identified as follows:

- number, operations and properties
- measurement
- geometry
- graphing.

An analysis of the current programs indicates:

A. A major emphasis on:

- number

with varying amounts of:

- measurement
- geometry
- graphing.

B. A noticeable expansion of the study of:

- geometry.

C. Earlier introduction to:

- decimals

and decreased emphasis on:

- fractions.

D. More modest emphasis on the role of:

- symbolism and terminology (precision in set language, other bases).

E. Instructional emphasis on:

- activity oriented approaches
- laboratory experiences
- use of manipulative materials.

F. A noticeable development in:

- assessment programs.

G. An overall description of the provincial curricula as a balance between:

- an understanding of the structure and language of mathematics
- sound skill development.

(But as will be noted later, this balance is not always reflected in classroom practice.)

2.4 School Personnel (Coordinators, Principals, Teachers)

Questions

Interviews were held with school board mathematics' directors, coordinators, consultants or supervisors, elementary principals and teachers, and questions were raised concerning:

A. Programs: development, implementation and content.

B. Services of ministries and provincial guidelines.

C. Assessment procedures.

D. Pre-service and in-service teacher education.

E. Current problems and needs.

In view of the wide variety of provincial guides and the fact that the fundamental decisions on curriculum content and instructional practice are currently made at the local level, it is difficult to present any carefully reasoned synthesis of school programs in elementary mathematics. But a summary of the responses to the questions indicates a number of common concerns amongst school personnel, and from the collection of local programs, some important implications are suggested.

Responses

A. Programs: Development, Implementation and Content

In general, the programs followed in schools are developed locally either by a district committee or the district coordinator, and reflect the provincial objectives. As would be anticipated, a great variety of programs have evolved. The following examples will illustrate:

a. the identification of major teaching responsibilities according to topics in one specific text series;

b. a listing of performance or behavioral objectives, according to topics from authorized text or texts with a suggested teaching sequence and recommended time-line;

c. specific objectives for each grade level, supplemented by activity units;

d. a listing of core objectives for each year with scope and sequence charts and suggested learning opportunities for content dealing with the themes of unifying concepts, number systems, measurement and geometry;

e. a listing of core objectives of skills for each grade level with detailed suggestions for methodology and sequencing of topics within three strands:

arithmetic, geometry and measurement;

f. objectives for each level identified under four strands:

number-numeration, operations and properties, geometry and graphing, measurement with extensive program materials: prescription pages, resource units, evaluation booklets and student profiles.

(Examples of selected district guides are included in Appendix B.)

The responsibility for district programs lies with the mathematics coordinator or consultant. When asked to describe their roles, these educators agreed that their task was a major and frustrating one. In addition to being responsible for the development, implementation and evaluation of programs, coordinators are expected to act as resource people whom principals and teachers may call for assistance with specific problems. These may range from orienting new teachers to programs, ordering materials and equipment to assisting children with learning problems. Other responsibilities include the organizing of workshops for special topics as program implementation, evaluation, geometry, metric measurement, and the development of a district resource centre or mathematics laboratory.

The one aspect currently given priority by most coordinators is the evaluation of programs and students.

B. Services of Ministries and Provincial Guidelines

In response to a question regarding the services provided by the ministries, most coordinators and principals acknowledged that only minimal assistance could be expected. This was due mainly to the lack of personnel and funds available, but in a number of situations it was felt that provincial personnel often are too far removed from actual practice to provide effective leadership. A few exceptions were noted where assessment studies had been carried out and in-service workshops in cooperation with school personnel were organized. Those provincial consultants who provide field services in distant areas of the provinces were considered very effective in their role. When asked to comment on the stated provincial objectives, all coordinators agreed that the programs developed at the local level were consistent with the goals and objectives of elementary mathematics as outlined by the ministry. However, teacher respondents indicated little knowledge of, or interest in provincial guides, and were only aware of ministry "impact" when province wide exams were administered or mandatory in-service workshops were presented.

C. Assessment Procedures

Although a number of schools reported reliance on large group standardized testing situations (e.g. Metropolitan Achievement, Canadian Basic Skills, or Stanford Diagnostic Math Tests) an increasing number of coordinators are developing assessment procedures of their own. A wide range of practices emerges:

a. achievement tests administered at end of school year focusing on computation and problem solving skills;

b. divisional diagnostic survey used at the beginning of school year;

c. criterion-referenced tests;

d. test items for each objective in the program (in the form of unit tests as well as test item bank) and survey tests administered at the end of school year.

When asked to comment on the purpose and use of a testing program, no clear picture emerged. Some gave as a reason "the examination of student progress", while others tested to evaluate program objectives. In certain situations, specific results are forwarded only to principals, while in other districts, summaries are made available to all for comparison purposes. On rare occasions results are restricted to use by supervisory personnel.

Teachers interviewed expressed concern for the amount of time required in administering tests, interpreting results and keeping records. This tends to "restrict actual teaching time".

D. Pre-Service and In-Service Teacher Education

School personnel were critical of the limited amount of time allotted to "Mathematics" in pre-service education programs. Most felt ill prepared as far as math academic background was concerned, and also inadequate in methodology currently practised in classroom situations. Few had attended worthwhile workshops or in-service courses, and only a limited number had attended conferences. It was felt by most respondents that pre-service education which provides little classroom exposure had minimal impact on one's success in teaching. It was also felt that in-service courses could be extremely valuable when offered by experienced, enthusiastic and well trained instructors, and when course content is related to classroom practice.

E. Current Problems and Needs

When asked to identify specific needs, coordinators were quick to point out their frustrations in fulfilling their expected role. They were concerned about the need for improved in-service education, particularly in the areas of program implementation, instructional practices in diagnosis and remediation, and assessment procedures. Reference was also made to the need for cooperation and support from principals, not only in improving teachers' instructional practices, but attitudes as well. Specific topics mentioned as concerns were: the need for clarifying and stressing basics, increased emphasis on problem solving, and the impact of calculators and 'Chisanbop'. All agreed that better communication with community, schools within the province and outside the province, was needed.

Principals and teachers supported the previously stated need for improved pre-service and in-service programs. Specific areas mentioned as important and neglected were basics, classroom management skills, learning problems and 'Chisanbop'. Reactions were varied where teachers were invited to comment on the effectiveness of local programs. On the one hand, the more general flexible guides were described as providing little assistance while on the other hand, the more extensive guides with assistance were considered too specific and restrictive.

The immediate problems cited by teachers focused on such practices as drill variety, long division algorithms, effective procedures for problem solving, reporting to parents, and introducing decimals.

2.5 Summary

There appears to be general agreement on the major topics, skills and concepts to be included in elementary programs:

A. The development of an understanding of:
   - number and numeration
   - measurement
   - geometry
   - graphing.

B. The development of skills in:
   - computational
   - measurement
   - problem solving.

But a closer examination of the programs suggests a difference of opinion concerning specific content to be included and the timeline for presenting it.

Examples of such variation can be cited from Sample Guides for Level I included in Appendix B. Although most programs recommend delaying the following topics until Level II:

A. introduction of multiplication and division operations;

B. introduction of standard units of measurement;

C. introduction of telling time by half and quarter hour;

D. introduction of block or bar graphs.

Some exceptions do exist, and similar variations can be found at later levels - e.g. the introduction and use of fractions and decimals.

In spite of the inclusion of the four major topics in all programs - number, measurement, geometry, graphing - the impression that emerges from a survey of teachers' comments and test samples, is that the allocation of

time appears to focus on only one: number. The topics of measurement, geometry and graphing are usually overlooked in favour of the development of computational skills with which teachers feel comfortable and value.

An analysis of the programs and survey of comments, observations and materials indicates the following:

A. strong emphasis on basics - interpreted mainly as computational skills;

B. early introduction to decimals - and continued emphasis on fractions;

C. noticeable increase in time spent on testing;

D. manipulative materials used mainly in first year by beginning teachers;

E. minimal attention given to:

   a. development of problem solving skills;

   b. applications of mathematics;

   c. development of positive self-concepts and positive attitudes towards mathematics.

2.6 Teacher Educators

Questions

During interviews with members of fifteen faculties of education questions were raised concerning:

A. Programs

B. Services offered

C. Ministry consultative services

D. School programs

E. Needs in mathematics' education

A somewhat similar picture emerges in a survey of teacher education programs as emerged in a study of provincial and local programs. Despite the wide variation in enrolments, program admission and requirements, course offerings, facilities and services, certain commonalities can be identified on a national basis. Likewise within provinces, a variety of programs and practices exists. Although provincial authorities are responsible for teacher certification and minimal guidelines are provided, flexible implementation appears to be acceptable.

Responses

A. Programs

Pre-Service:

Most pre-service programs designed to prepare elementary teachers require either three or four years study following completion of secondary school. A few institutions offer a one-year program following an initial degree.

The majority of elementary education students follow a general program with few taking a concentration in mathematics. A typical

program requires students to take at least:

- one course in mathematics content (e.g. mathematics for elementary teachers, or fundamentals in mathematics or basic mathematics, usually 3 credits), and
- one course in mathematics methods (e.g. curriculum and instruction, math programs and instructional techniques, usually 3 credits).

However, exceptions do exist. There are programs where a total of four courses (two content and two methods) are required (12 credits). And there are programs where only ten two-hour workshops are recommended during the entire three-year period.

Sequencing of courses presents a varied pattern as well. Content courses are usually taken before methods, but they are taken concurrently in some programs, and in reverse order in others. However, most are completed before student teaching experiences.

In some universities, departments are able to offer optional courses - such as Development of Math Education, Current Trends in Math Education, Diagnosis in Elementary School Mathematics. But many of these are offered as in-service programs as well. (Selected samples of courses can be found in Appendix C.)

Most programs require some form of lab type of experience in methods courses, but these are often restricted because of lack of materials, facilities and time. A great variation exists in facilities provided. Some universities have spacious labs with extensive equipment and library facilities, while others provide mainly classroom accommodations. Other aspects of programs which are neglected because of time are consideration of such topics as "Use of calculators", "Less able and gifted students", "Evaluation".

A noticeable trend in many programs is the preparation of a generalist in elementary education and this has resulted in a shift from individual courses being offered in lecture halls, to a more integrated approach with core programs being based in school settings. Longer periods of practicum or internship have been introduced, and school and faculty personnel work as a team. This change of role for the university lecturer has caused some concern as will be noted in the Summary section.

Graduate:

Specific information of graduate programs in mathematics education is incomplete, but of those universities surveyed, four indicated a variety of offerings: Memorial, U.N.B., Alberta, U.B.C. However, most program directors reported a significant decline in student enrolment. Faced with budgetary limitations, they have been forced to curtail offerings. An unfortunate result has been a de-emphasis on research opportunities in math education.

In-Service:

With the decreased enrolment in pre-service programs, attention has turned to in-service education. Once again a variety of situations exist throughout the country. In some provinces, universities have organized programs in mathematics specifically for in-service training, and have offered these through adult or continuing education departments, or through field services, extension, or educational leadership divisions. In others, provincial ministries have been responsible for organizing courses and have called upon university personnel to teach them. A noticeable trend is for school districts to rely mainly on their own

resources for the design and implementation of programs. Most successful ventures appear to be those where both school and university personnel cooperate in the offering of courses. The following methods of instruction topics are reported as being most frequently requested:

- Problem solving
- Less able and gifted students
- Instructional materials
- Mathematical Games
- Classroom calculators
- Testing
- Remediation.

B. Services Offered

A wide difference exists in the size of mathematics education departments and in the role of individual members. In smaller units members' main responsibility is the teaching of discreet courses and the supervision of students in school settings, while in larger units, there is greater diversification of efforts. Many members are called upon to act as core leaders, supervisors or advisors in school-based programs, or coordinators of special projects in addition to teaching assignments. With such increased emphasis on school experiences and in-service education, and with fewer graduate assistants, department members are unable to extend their efforts into research projects and related publications.

C. Ministry Consultative Services

In general, most teacher educators appear unaware of services provided by ministries of education. With the exception of those who are actively involved in program development, implementation or evaluation - either as an individual named by the ministry or as university representative on a provincial committee - there is little communication between the two organizations. In some provinces university members have expressed concern about the apparent trend towards centralization with highly structured programs and rigid assessment procedures. But in other situations, positive comments were made of opportunities for research projects through ministry fundings. Most educators were in agreement with the provincial objectives, but noted little evidence of their implementation.

D. School Programs

When asked to comment on school programs, most teacher educators responded positively about recent progress in program development, particularly where both local and university personnel have been involved. But concern has been expressed about:

- over emphasis on number and limited attention given to geometry and measurement;
- interpretation of problem solving as word problems;
- increasing emphasis on testing;
- use of behavioral objectives;
- lack of emphasis on applications;
- little use made of calculators.

Most teacher educators commended district coordinators or consultants for including teachers in the designing, implementation, and evaluation of new programs. This has resulted in many instances on increased emphasis on local needs and a declining reliance on the use of one specific text.

E. Needs in Mathematics Education

Respondents indicated the following as being the needs in mathematics education:

- more time in general program for math courses: content and methods in particular, but also instruction in measurement, diagnosis and remediation, special education needs;
- improved facilities - laboratory accommodation with more extensive equipment, library and curriculum materials;
- improved administrative procedures regarding teaching assignments, time allotments and sequencing of courses;
- more opportunities for research and publications;
- greater involvement in school community;
- further extension of in-service and graduate offerings;
- improved communication with other universities;
- a better understanding on the part of curriculum developers as to the mathematical needs of today's children.

2.7 Summary

Despite the wide variation in enrolments, program requirements, course offerings and facilities, there appears to be some general trends in teacher education programs.

The marked decline in enrolment in initial preparation has necessitated a shift of emphasis to in-service programs. This change has resulted in greater involvement in the school community and in the development of cooperative projects. Courses and workshops offered by teacher educators are now becoming more respected and requested because they are related to the needs of teachers.

The reality of teacher supply and demand has equally influenced pre-service programs in most universities. There is a definite trend to prepare the generalist in elementary education - and this has resulted in a more integrated approach. Attempts are being made to integrate 'theories of learning' with practice, and core programs are identified with 'school-based experiences'. Internships and practicums are given priority over previous time-allotted methods courses. This shift has resulted in a change of role for the instructor - a difficult assignment for some. Not only must members become accustomed to working as a team in the development, presentation and assessing of a program, but they must adapt to a shorter time period being allotted to "mathematics". This requires careful clarification of objectives and priorities. In a number of instances, this adjustment has resulted in frustration on the part of both instructor and students.

The identification of priorities in content presents a challenge to all teacher educators. Issues debated appear to focus more on requirements than on appropriateness and relevancy of topics. A survey of offerings indicates general agreement on such topics in content courses as: arithmetic function,

algebra, and geometry, with diminishing emphasis on probability, statistics, and computer mathematics. Methods courses' topics focus mainly on approaches and materials for teaching number and operations, with minimal reference to geometry, measurement, applications, problem solving, evaluation, remediation, calculator usage.

Although respondents recognized the need for improved integration between content and methods, and between methods and classroom practice, few supported existing efforts of program revision committees to overcome administrative restrictions. This attitude and the limited number of innovative practices in present math courses would appear to justify the criticism levelled at many math education departments that they fail to react to and accommodate trends in teacher education in general. However, the recently formed Canadian Mathematics Education Study Group is evidence that Canadian mathematics educators are questioning the state of the art and are working towards clarification of and agreement on common goals. It is to be hoped that this group will provide needed leadership.

PART 3. OUR FUTURE RESPONSIBILITIES

The future of elementary school mathematics in Canada can be either positive or negative.

NEGATIVE:

- If we fail to recognize the future impact of such technological changes as calculators, computers, micro-processors, television, and the impact of learning research.

- If we continue to struggle with questions of curriculum, goals, content, meaningful instruction, evaluation, diagnosis, remediation, acceleration, in-service needs, in complete isolation with feelings either of uncertainty or of unconcern.

POSITIVE:

+ If we recognize that the future for the five-to-eleven year old will mean more than the replacement of scratch pads with calculators. With word processors beginning to replace typewriters, home computer television screens competing with daily newspaper ads, talk-back computer terminals and purse-sized television becoming more common, it is inevitable that the most important requirement of such an exploding Information Society will not be the acquiring of knowledge, but the ability to use it.

+ If we re-examine our present objectives which focus mainly on number and computational skills, and consider the need for emphasizing such basics as:

. applications of mathematics to daily living

. estimation and approximation

. organizing and interpreting data

. measurement and geometry

. appropriate computational skills, including calculator usage.

+ If educators at all levels assume responsibility for influencing change. Curriculum developers at both local and ministry levels and school administrators must make a serious commitment to a continuing program of in-service education, one which will require more than the one- or two-day workshop sessions where materials and methods are shared. Faculties of Education and professional organizations will need to provide programs and courses with greater emphasis on:

- . curriculum planning
- . evaluation
- . diagnosis and remediation
- . learning disabilities
- . applications in mathematics
- . computer literacy.

Teachers must take advantage of every opportunity to assure improvement in mathematical instruction - by sharing ideas, observing each other, and becoming involved in courses and curriculum and research projects.

+ If more effective leadership is provided in the area of research. Although a number of studies in mathematics curriculum and instruction and in classroom environment have been conducted in universities and have offered definite direction, attempts to identify teacher effectiveness so far have proven unsuccessful. This may be the area where joint co-operation of teacher educators and school personnel, supported by ministry funds, could produce positive results. Rather than attempting to define an "effective teacher" by studying such aspects as styles, strategies, environments and quality, a clearer definition might evolve by focusing on children learning - specifically by studying their mathematical activities scientifically.

Such a study would involve serious commitment by many educators - teachers, administrators, curriculum planners, educational researchers and math educators - and could provide effective leadership.

+ If a national organization is formed to assume responsibility for collecting, coordinating and disseminating information on:

. curriculum guidelines and program

. curriculum studies

. evaluation instruments

. program innovations

. teacher education programs (pre-service and in-service needs).

Such a communication network organized at the national level would facilitate the identification of developments at the provincial and local levels. This is vital.

The future of elementary school mathematics in Canada can be positive.

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APPENDIX A

MINISTRIES OF EDUCATION

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252 Bloor Street West, Suite S-500
Toronto, Ontario
M5S 1V5

NEWFOUNDLAND

Department of Education
Confederation Building
P.O. Box 2017
St. John's
A1C 5R9

Programme of Studies, 1978-79

Approved textbook: Investigating School Mathematics, Books 1-6

PRINCE EDWARD ISLAND

Department of Education
Provincial Building
Rockford Street
Charlottetown
C1A 7N8

A Style for Every Child, 1977-78: Amendments, 1978

Authorized programmes: Series M-Mathematics, Years I-III

(Under review): Elementary School Mathematics, Years IV-VI

NOVA SCOTIA

Department of Education
Trade Mart Building
P.O. Box 578
Halifax
B3J 2S9

Public School Programmes, 1978-79

Mathematics: Primary - Six, 1977

Textbooks as sources: Investigating School Mathematics
Elementary Mathematics
Project Mathematics

NEW BRUNSWICK

Department of Education
King's Place
P.O. Box 6000
Fredericton
E3B 5H1

Handbook for Elementary Schools, 1977-78

Prescribed textbook: Elementary School Mathematics

(Under consideration): Mathways
Project Mathematics

QUEBEC

Ministère de l'Education
600, rue Fullum, 6e étage
Montréal
H2K 4G6

Programme-cadre: La mathématique à la classe maternelle et au niveau élémentaire, 1976

Elémentaire mathématiques; Programme-cadre, 1973

Approved textbooks: (Bulletin 16-4051)
- Investigating School Mathematics
- Mathways
- Project Mathematics
- Series M-Mathematics
- Elementary Mathematics
- Mathématiques

ONTARIO

Ministry of Education
Mowat Block - 16th Floor
Queen's Park
Toronto
M7A 1L2

Formative Years, 1975

Education in the Primary and Junior Divisions, 1975

Approved textbooks: (Circular 14, 1977)
- Mathways
- Project Math

MANITOBA

Department of Education
Robert Fletcher Building
1181 Portage Avenue
Winnipeg
R3G 0T3

Mathematics, K-6, 1978

Approved textbooks:
- Starting Points in Mathematics, 1-6
- Mathways, 1-6
- Mathematics Learning System, 4-6
- Investigating School Mathematics, 4-6

SASKATCHEWAN

Department of Education
2220 College Avenue
Regina
S4P 3V7

Mathematics Curriculum Guide, Divisions I and II, 1977

Approved textbooks:
- Investigating School Mathematics
- Project Mathematics
- Essential Modern Mathematics

ALBERTA

Department of Education
Devonian Building, West Tower
11160 Jasper Avenue
Edmonton
T5R 0L1

Program of Studies for Elementary Schools, 1978

Elementary Mathematics - Curriculum Guide, 1977

Approved textbooks: Mathematics Learning System
Investigating School Mathematics
Project Mathematics

BRITISH COLUMBIA

Ministry of Education
835 Humboldt Street
Victoria
V8V 2M4

Guide to the Core Curriculum, 1977

Mathematics Curriculum Guide, Years 1-2, 1978

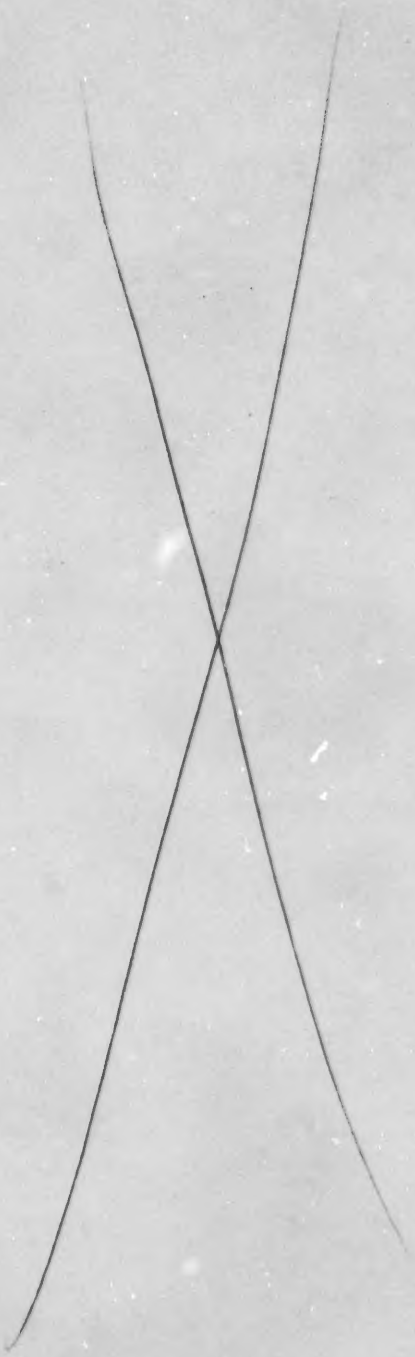
Approved textbooks: Investigating School Mathematics
Project Mathematics
Elementary Mathematics

A P P E N D I X B

Samples of

SCHOOL MATHEMATICS PROGRAMS

1978-79



BALDWIN-CARTIER SCHOOL BOARD

BALDWIN-CARTIER SCHOOL BOARD

GRADE ONE MATHEMATICS

MAJOR TEACHING RESPONSIBILITIES

1. Build number readiness concepts through work with comparison of sets.
2. Develop an understanding of cardinal numbers.
3. Mastery of the addition and subtraction facts related to sums through 10.
4. Develop meaning of the symbol "one zero" and continue with two-digit place value through 99.
5. Introduce addition and subtraction facts related to sums 11 through 20.
6. Introduce some basic geometry concepts related to size comparison and identification of basic shapes.
7. Provide exploratory experiences with additional topics on telling time, money, linear and liquid measure, missing addends, fraction, and inequalities.

ST. JAMES-ASSINIBOIA SCHOOL DIVISION NO. 2

GRADE I - MODULE I

BEHAVIORAL OBJECTIVES - READINESS FOR NUMBER DEVELOPMENT
(With appropriate vocabulary)

The student should be able to:

1. Compare two objects for differences or similarity.
2. Compare positions of objects.
3. Arrange objects in order.
4. Identify and reproduce equivalent sets.
5. Identify a set that has more than or less than a given set.
6. Recognize, reproduce, continue and describe orally a concrete pattern and action pattern and a picture pattern.
7. Rote count to 10.
8. Enumerate cardinal and ordinal numbers to 10.
9. Combine 2 sets to form a larger set.
10. Remove a subset from a given set.

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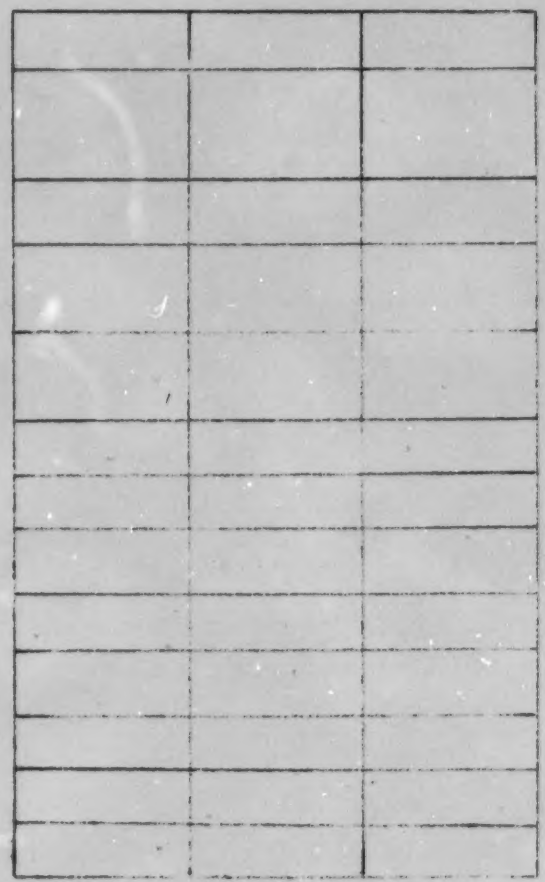
GRADE I - MODULE II

BEHAVIORAL OBJECTIVES - STUDY OF WHOLE NUMBERS FROM 0 TO 10

The student should be able to:

1. Identify, compare and order sets with 1 to 10 elements.
2. Identify an empty set and realize that the cardinal value of a given set does not change when the empty set is combined with it or removed from it.
3. Reproduce a set equivalent to a given set or a named set.
4. Identify a set by its number name (its cardinal value), and find the corresponding numeral.
5. Order numbers by finding the number and writing the numeral before or after, or between given numbers.
6. Form a new set which has 1 or 2 more or less than a given set.
7. Combine 2 sets to form a larger set.
8. Remove a subset from a given set.
9. Read, interpret and write number sentences using symbols.
10. Find the difference between 2 sets by matching.
11. Form the numerals for 0 to 9.
12. Write the numerals in sequence from 0 to 9.
13. Understand the relationship between addition and subtraction.



GRADE I - MODULE II

BEHAVIORAL OBJECTIVES - STUDY OF WHOLE NUMBERS FROM 0 TO 10
(Continued)

14. Name a number in many ways.
15. Add two addends vertically.
16. Recognize and count sets of twos, threes, fours and fives.
17. Reproduce concretely sets of twos.
18. Count by twos, threes, fours and fives.
19. Interpret a repeated addition experience orally and in writing.
20. Find and count equivalent subsets in a given set.

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GRADE I - MODULE III

BEHAVIORAL OBJECTIVES - FRACTIONS

The student should be able to:

1. Recognize and understand that a whole is made up of 2 equal parts and that each part is named and written as $\frac{1}{2}$.
2. Recognize and understand that a whole is made up of 4 equal parts and that each part is named and written as $\frac{1}{4}$.
3. Recognize $\frac{1}{10}$ and 0.1 as fractions.

GRADE I - MODULE IV

BEHAVIORAL OBJECTIVES - GEOMETRY (3D AND 2D)

The student should be able to:

1. Recognize, compare and classify 3-D objects (sphere, cylinder, cuboid cone).
2. Recognize, compare and classify a square, rectangle, circle and triangle.
3. Recognize symmetry in 3-D shapes.

GRADE I - MODULE V

BEHAVIORAL OBJECTIVES - GRAPHING

The student should be able to:

1. Collect and represent information concretely and pictorially and interpret the outcome of this representation.
2. Construct concrete and pictorial graphs.

GRADE I - MODULE VI

BEHAVIORAL OBJECTIVES - MEASUREMENT

A. Linear Measurement

The student should be able to:

1. Use non-standard and standard (cm, m) units to measure the length of an object.
2. Use non-standard and standard (cm, m) units to compare the length of 2 objects.

B. Readiness for Other Measurement

The student should be able to:

1. Show some understanding of area, volume, capacity, and mass.

C. Time

The student should be able to:

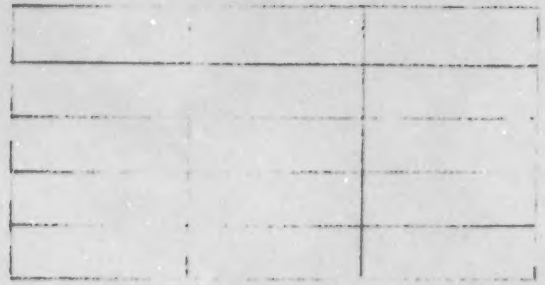
1. Identify and relate events to appropriate parts of the day.
2. Name the days of the week in sequence.
3. Begin to read a calendar.
4. Name the months of the year and relate important events to appropriate months.
5. Tell time to the hour and relating the time to specific events.
6. Identify and name 1¢, 5¢, 10¢, 25¢ and use 1¢ and 5¢ in real and play experiences.

GRADE I - MODULE VII

BEHAVIORAL OBJECTIVES - PROBLEM SOLVING (ORAL)

The student should be able to:

1. Represent the problem concretely and pictorially.
2. Perform the action indicated in the problem.
3. Describe orally the action performed.
4. Relate written sentences to oral statements.
5. Answer the question in the problem.



LAKESHORE SCHOOL BOARD

LAKESHORE SCHOOL BOARD

MATHEMATICS

Rationale

Mathematical thought and language continue to influence our contemporary society. The K-6 Mathematics programme aims to provide learning opportunities so that all children will:

1. explore and learn Mathematical concepts, properties, rules, relationships and algorithms;

2. progressively become familiar with certain elements (verbal, graphic and symbolic) of the Mathematical language, which are used for communications;

3. extend and maintain, and in some instances, recall in detail, a certain number of skills or techniques;

4. develop a positive attitude towards learning of mathematics and its role in society.

Aims

a. to cover basic numerical concepts and operations;

b. to foster comprehension of the principles of numeration;

c. to help pupils master fundamental algorithms of elementary arithmetic;

d. to introduce the basic geometrical concepts related to physical space;

e. to develop the ability to express a problem in mathematical terms and solve it by appropriate means;

f. to provide an insight into mathematical structures;

g. to develop a positive attitude toward the implementation of the metric system;

h. to develop a positive attitude toward mathematics and its role in society;

i. to familiarize pupils with the modes of thought of mathematics;

j. to familiarize pupils with certain tools developed by mathematicians.

LEVEL I

SETS AND LOGIC

The student will be able to:

101 sort groups of objects according to size, shape and colour

102 recognize equivalent sets (sets with same number of members; 1-1 matching)

103 sort given objects into equivalent sets

104 identify sets which have at least one more or one less member than the other

105 correctly use the term "empty set" to describe a set having no members

106 identify the set of objects which is common to two or more sets of objects (the intersection set)

NUMBERS AND NUMERALS

107 identify and record the cardinal number of a set with 0-10 members

108 recognize and use the ordinal numbers first to tenth

ADDITION AND SUBTRACTION

109 solve addition problems with sums through 5, using the equation form

110 complete number sentences by filling in the missing addend or symbol; sums through 5

111 solve subtraction problems with sums through 5; using the equation form

112 solve addition and subtraction problems with sums through 5; using the vertical form

113 solve addition and subtraction problems with sums through 5; using both the equation and vertical forms

114 solve addition problems with sums of 6 and 7, using the equation form

115 solve subtraction problems with sums of 6 and 7, using the vertical form

116 complete number sentences by filling in the missing addend or symbol; sums through 7

117 solve addition problems with three addends, using both the equation and vertical forms; sums through 7

ADDITION AND SUBTRACTION (continued)

118 solve addition problems with sums of 8 and 9 using:

i) the equation form
ii) the vertical form

119 solve subtraction problems with sums of 8 and 9 using:

i) the equation form
ii) the vertical form

120 solve addition and subtraction problems with sums through 10 using:

i) the equation form
ii) the vertical form

121 solve addition problems with 3 addends using both the equation and vertical forms; sums through 10

122 express a number (up to 10) by different numerals

123 solve addition problems with sums through 18 using the equation form (with manipulative aids)

124 complete number sentences by filling in the missing addend sums through 18 (with manipulative aids)

125 solve addition problems with sums through 18 using the vertical form (with manipulative aids)

COUNTING, ORDERING AND PLACE VALUE

126 count orally from 0-100

127 read and identify numerals to 100

128 order and write any set of numerals between 0-40

129 identify odd and even numbers to 100

130 count by 10's to 100

131 count by 2's to 20

132 count by 5's to 50

133 use correctly the symbols or to compare any two numbers less than 40

134 group a number of objects up to 100 into tens and ones and record the correct numeral

135 interpret two-digit numerals as groupings of tens and ones

MEASUREMENT

LENGTH

136 compare objects using various terms: larger, thicker, heavier, longer, shorter, bigger, smaller, etc.

137 estimate and measure the lengths of various objects using non-standard units, e.g., hand spans, etc.

138 estimate and compare the lengths of various objects with the same length of the metre stick, e.g., longer than a metre, same as a metre, shorter than a metre, etc.

139 estimate and measure the length of various objects in centimetres

MASS

140 estimate and measure the mass of various objects using non-standard units

141 estimate and compare the mass of objects with the 1 kg mass and 0,5 kg mass

CAPACITY

142 estimate and measure the capacity of various containers using non-standard units

MONEY

143 recognize and name all Canadian coins

144 state the value of all Canadian coins and find the value of various sets of coins

145 find set of coins with the same value

TIME

146 classify and order daily events

147 demonstrate a knowledge of common blocks of time, e.g., year, month, day, hour

148 tell the time the clock shows using the phrase ". . . o'clock"

149 place the hands of the clock correctly to show a given time (to the full hour)

GRAPHING

150 construct and interpret simple graphs, e.g.:

a) 3-D graphs
b) picture graphs
c) block graphs
d) bar graphs

GEOMETRY - SOLID

151 match solids from the environment to various geometric solids, e.g., cube, cylinder, cuboid, cone, sphere, prism, and pyramid

152 identify various geometric solids: cone, sphere, prism, cube, etc.

GEOMETRY - PLANE

153 match attribute blocks with corresponding figures

154 identify and name a set of geometric figures: the triangle, rectangle, square and circle

155 trace plane geometric figures using dot paper ruler and pencil

156 make representations of plane geometric figures using concrete materials

NORTH YORK BOARD OF EDUCATION

NORTH YORK BOARD OF EDUCATION

Aims of the Mathematics Program

- To help the learner develop concepts and skills related to:
  - sets and number
  - shapes and space
  - measurement
- To help the learner achieve computational skills based on understanding.
- To help the learner develop his space perception.
- To help the learner develop interest, appreciation and enjoyment of mathematics.
- To expand the learner's interest and enjoyment of art and structure in his environment by recognizing patterns, designs and symmetry.
- To help the learner think and express himself logically through manipulative devices, diagrams and words.
- To help the learner appreciate the use of mathematics in everyday experiences.
- To encourage the learner to investigate concepts in greater depth as his interests and abilities expand.
- To involve the learner as an active participant in the learning process both individually and in groups.
- To foster self-confidence by acquiring the skills to deal with the problems of life and the marketplace.

NUMBER (I)

1. Given a set of objects, sorts into sets and explains the sorting rule.

2. Using a negative property, identifies objects not in a given set (i.e., "These are not round".)

3. Given a sorting rule, selects objects belonging to that set.

4. Given number words for numbers zero to twenty-five, reads words orally and matches words with numerals or sets of objects. Given numbers, writes number words zero to twenty-five.

5. Identifies what number comes immediately after a given number, between two numbers, or before any given number for numbers to 25 with or without structured groups.

6. Counts orally, and reads and writes numbers 1 to 100.

7. Counts by twos, fives, and tens.

8. Writes the digit which is in the 10's and 1's place as requested for a given number. States the place value of a particular digit.

9. Given an ordered set of from one to ten objects, identifies the object with the specified ordinal position from first through tenth.

10. States and illustrates addition and subtraction facts to 18.

11. Illustrates multiplication as repeated addition using sets of objects.

12. Illustrates division by partitioning a set of objects into equal subsets.

13. Divides a whole object into halves, thirds, or fourths and identifies an object divided into halves, thirds, or fourths.

MEASUREMENT (I)

1. Correctly uses and gives illustrations for:

   a) comparative words such as:

long, short	tall, short	hot, cold	big, small
high, low	heavy, light	fast, slow	near, far
			thick, thin

   b) words of position in space such as:

right, left	up, down	between
top, bottom	above, below	behind, in front of

MEASUREMENT (I) (Continued)

2. Measures lengths of objects or distances, using arbitrary units (e.g., steps, spans, arm lengths, book lengths) to the nearest unit.

3. Estimates and measures in terms of the unit to be used, the number of units of length in a given length. For example, the number of paces in the length of the room.

4. Identifies by physically comparing them, objects that are "twice as long", "half as high", "twice as heavy", etc.

5. Identifies the larger of two surfaces as the one that requires more colouring or painting.

6. Covers a surface as completely as possible without overlapping using non-standard units (covers a tabletop with sheets of paper the same size and shape).

7. Estimates and measures (a) the number of smaller containers required to fill a larger container (nearest whole unit); (b) the number of times a smaller container can be filled with the material from a larger container.

8. Identifies containers that have (nearly) the same, greater, or less, capacity (volume).

9. Given two or three objects, places them in order of mass and identifies the heaviest and the lightest.

10. Uses washers or other arbitrary unit to measure the masses of given objects to the nearest unit.

11. Uses a thermometer to record and compare temperatures inside and outside the classroom and answers questions such as "Is it cooler (colder) or warmer (hotter) today than yesterday?"

12. Using a clock, tells time on the hour, half hour and quarter hour.

13. Associates 1 hour of time with regular class activities. For example, Sesame Street lasts 1 hour, math and reading together take longer than an hour.

14. Identifies and names pennies, nickles and dimes and states the value, in cents, of each coin, or set of coins (sums of 24¢).

15. Constructs and interprets a column graph or pictograph illustrating choices made by a group of persons (e.g., favorite sports, foods, etc.).

GEOMETRY (I)

1. Given models of sphere, cube, cone, cylinder, triangular and square pyramid, sorts into sets and explains the sorting rule.

2. Given a set of shapes (including squares, circles, rectangles and triangles) sorts the set into subsets according to shape.

3. Identifies objects from the environment that have shapes similar to circles, squares, rectangles and triangles.

4. Given a 5 x 5 geoboard and one elastic makes a shape of design.

5. Uses a geoboard and several elastics. Makes shapes and designs.

6. Copies simple designs or shapes from geoboard to geoboard, geoboard to geopaper, geopaper to geopaper, geopaper to geoboard.

7. Uses a geoboard and two elastics to make two identical shapes on the same board.

8. Solves problems relating a shape and the number of pegs the shape touches, or the number of pegs inside a shape. For example, makes a shape that touches 4 pegs; makes a shape that has 3 pegs inside.

9. Makes specific plane shapes using 1 elastic. For example, makes another triangle the same; makes a larger square.

HAMILTON BOARD OF EDUCATION

HAMILTON BOARD OF EDUCATION

Note: Curriculum guide includes Core Concepts and Skills, Strategies, Teacher Notes, and Suggested Sequences.

A SUGGESTION FOR SEQUENCING THE LEVEL I PROGRAM

The following sequence was developed by practicing classroom teachers and is presented for your information as a suggestion only. This is provided as an example of a level I program which integrates arithmetic, geometry and measurement throughout the year. On using this example or on developing your own sequence to meet the specific needs of your class, care should be taken to provide a balance of topics from the three major strands throughout the year's program.

M12 - Time periods during the day.

M13 - Sequence of events during the day, week, month and year.

M16 - Speed.

A12 - Ordinal concept - 1st to 5th.

A1 - Identify characteristics using five senses.

A2 - Identify characteristics of two or more objects.

A3 - Sort objects, make sets with one common characteristic.

G1 - Recognize characteristics of 3-D shapes.

G2 - Relate 3-D shapes to environment.

A3 - Sort objects, make sets with one common characteristic using 3-D models.

M1 - Direct comparisons of lengths.

M4 - Compare directly, two or more areas.

M6 - Compare directly, two or more volumes.

M8 - Compare directly, two or more masses.

A3 - Sort objects, make sets using measurement as a characteristic.

G7 - Relate 2-D shapes to environment.

G9 - Identify rectangles, squares, triangles and circles.

G10 - Language related to 2-D shapes.

A3 - Sort objects, make sets with one common characteristic using 2-D shapes.

A4 - Sort objects, make sets - more than one common characteristic.

Note: A4 could be inserted earlier according to the child's readiness.

A5 - One-to-one correspondence.

A6 - Numeral to a set (0 to 9).

A7 - Compare sets (0 to 9).

A10 - Rational count to 50.

A25 - Collect, sort and tabulate data.

A26 - Construct pictograph, bar graph.

A27 - Interpret pictograph, bar graph.

Note: For A25, A26, and A27, graphing should be used intermittently where appropriate, throughout the year.

A11 - Rote count - 1's to 100.

A11 - Rote count - 2's to 20.

A13 - Addition as joining of sets to 10.

A14 - Addition facts to 10.

A15 - Oral problems using addition.

M1 - Direct comparisons of lengths including sequencing.

M2 - Measure length - non-standard units.

M3 - Estimate, then measure lengths with non-standard units.

M4 - Compare directly, two or more areas.

M5 - Measure areas - non-standard units.

A17 - Subtraction as separating of sets to 10.

A18 - Relate subtraction to addition.

A19 - Record subtraction using symbols.

A20 - Oral problems using subtraction.

M6 - Compare directly, two or more volumes.

M7 - Measure volumes - non-standard units.

G3 - Movement of 3-D shapes.

G4 - Patterns using 3-D shapes.

G5 - Similarities and differences of 3-D shapes.

G6 - Identify 3-D shapes.

ARITHMETIC: LEVEL I

Note: The following kits, available through Science Technician Services, will provide a useful resource for your Arithmetic program: cereals, hearing sounds, shoes, touching things.

Concept or Skill The student should:	Strategies (Suggested Methods and Activities)	Teacher Notes
1. Identify characteristics of an object using the five senses.	Hide something in a bag. Child describes and identifies by touch. "Find something that . . ." Object is hidden. Use a number of senses to describe it. Partner or class attempts to identify it.	One characteristic at a time at first. One or more characteristics later.
2. Identify common characteristics of two or more objects.	Attribute (logic) blocks, beads, miscl. articles (2D and 3D) found in classroom. "Find 2 objects which have something in common." "What is the same about these objects?" Provide classification table (centre). Teacher and/or students bring articles to compare.	Use one or more of the characteristics at a time (taste - sweet and sour). Work individually, pairs, or groups.
3. Sort objects and make sets with one common characteristic.	Buttons, bottlecaps, attribute blocks, straws, scraps of materials, plasticine, candy, geometric solids, etc. Child sorts randomly and makes a set. Enclose set in yarn, wool or string. Child decides on the characteristic (e.g., all roll, all rectangular, all sweet smelling, etc.).	Not always visual. Use the five senses. Incorporate with measurement (e.g., same length, same mass, etc.).

EDMONTON PUBLIC SCHOOL BOARD

EDMONTON PUBLIC SCHOOL BOARD

ELEMENTARY MATHEMATICS PROGRAM (1976)

A. THE PROGRAM

The elementary mathematics program of the Edmonton Public Schools is an outline and guide for the teaching of mathematics, grades one through six. This program is consistent with the goals and objectives of elementary mathematics as outlined by the Provincial Department of Education.

The scope of the elementary mathematics program has been divided into four strands:

1. Number-numeration
2. Operations and properties
3. Geometry and graphing
4. Measurement.

1. Number-numeration

a) The pupil should have an understanding of the natural numbers and the positive rationals (common and decimal fractions).

b) The pupil should understand the properties of the base ten number system which gives him a systematic way of naming natural numbers.

2. Operations and Properties

The pupil should be able to apply the four operations and their properties to problems involving the natural numbers and the rationals.

3. Geometry and Graphing

a) The pupil should develop an understanding of fundamental geometric concepts, which gives him a system for conceptualizing real world objects and a vocabulary to describe his environment.

b) The pupil should be able to interpret graphs and use graphs to show collections to data in real world situations.

4. Measurement

The pupil should learn what it means to measure, how to measure, and the necessity for standard units of linear, square and cubic measure, capacity, mass and time.

Each of the four strands contain a number of specific objectives. The objectives are divided into six levels, A-F, to correspond with the six elementary grades. These objectives outline the specific mathematical skills and concepts that should be taught at each grade level. (A detailed list of objectives is included in each teacher program handbook.) The objectives are considered core material unless preceded by an asterisk which indicates extension.

OBJECTIVES: LEVEL A

Number-numeration

1. Identify two equivalent sets or sets with more or fewer members by placing members of a set in one-to-one correspondence.
2. Associate a set of objects with a numeral 0 through 9.
3. Read, write and order numerals 0 through 9.
4. Develop place value concepts through two digits.
5. Read, write and order numerals 0 through 9.
6. Identify the fractions 1/2, 1/4 and 1/3.
7. Use ordinals through tenths.

Operations and Properties

1. Identify the processes of addition and subtraction.
2. Master the basic facts of addition and subtraction through 9.
3. Solve oral story problems involving only complete basic fact sentences.
4. Master the basic facts of addition and subtraction to 18.

Measurement

1. Compare lengths of two or more objects using terms such as "longer than", "shorter than", etc.
2. Find the approximate length of a given object using non-standard units of measure.
3. Compare masses of two or more objects using terms such as "heavier than", "lighter than", etc.
4. Compare capacities of two or more containers using terms such as "more than", "less than", etc.
5. Find the approximate capacity of a container using a non-standard unit of measure.
6. Observe the differences in temperature using the terminology hot, warm, cool and cold (senses only).
7. Tell time to the hour.

Measurement (continued)

8. Know the days of the week in order.

9. Recognize and state the singular value of the one dollar bill and the one cent, five cent, ten cent, twenty-five cent and fifty cent coins.

Geometry

1. Classify according to surfaces and shapes, cones, cylinders, spheres and polyhedra.

2. Identify triangles, squares, rectangles and circles on a 3-D shape.

3. Identify and classify according to shape 2-D drawings of triangles, squares, rectangles and circles.

4. Match a 3-D shape with the 2-D representation of that shape.

SAMPLE UNIT OF GEOMETRY - GENERAL OBJECTIVES

While working through this unit the child should be able to classify, identify, and match geometric shapes, figures and objects in his environment.

GEOMETRY OBJECTIVES

Level A

1. Classify according to surfaces and shapes, cones, cylinders, spheres and polyhedra.

2. Identify triangles, squares, rectangles, and circules on a 3-D shape.

3. Identify and classify according to shape 2-D drawings of triangles, squares, rectangles, and circles.

4. Match a 3-D shape with the 2-D representation of that shape.

Level B

1. Identify edges, corner points (vertices) and faces of 3-D shapes.

2. Classify, identify and name triangles, squares, rectangles, and circles with respect to sides, corner points (vertices) and shape.

3. Demonstrate plane symmetry by matching halves through paper folding and cutting.

4. Recognize open and closed curves.

OBJECTIVES

The child will be able to classify according to surfaces and shapes; cones, cylinders, spheres, and polyhedra.

MATERIALS LIST

1. A box of odds and ends including such things as:

   ball bearings, soap bars, books, pieces of lumber, blocks of wax, erasers, party hats, tops, boxes, marbles, blocks, balls, paper cups, candles, cans, crayons, rods, paper rolls, funnels, hair rollers, batteries, beads, pencils, rubber hose, pair of die, etc.

   The odds and ends collected should be in a variety of colors, sizes, and materials, such as: glass, wood, paper, metal, styrofoam, plastic, wax, rubber, so that the children learn to disregard these attributes and concentrate on shape only.

2. Two sheets of construction paper.

3. Eight hoops.

4. Geometric models (available in the Science-A Process Approach (S-APA) Level a kit).

REFERENCE MATERIAL

1. Science - A Process Approach, Part A, Observing 2, Lesson C

2. Booklets:
   - My Book of Cuboids and Rectangles — Approx. Price $3.05
   - My Book of Cubes and Squares
   - My Book of Spheres, Cylinders and Circles
   - My Book of Cones, Pyramids and Triangles
   - Find the Shape

   Authors: Jenny Taylor and Terry Ingleby

   Publishers: Longman Canada Limited,
   55 Barber Green Road,
   Don Mills 403, Ontario.

CONTENT OVERVIEW

The specific Level A objectives should be achieved by the end of the first year. This geometry unit is designed to be presented as one complete package.

ORGANIZATION OF THE UNIT

This unit is composed of four modules. Each module has two sections as follows:

(a) Introductory Section

(b) Level A Content - Procedures and materials for the teaching of Level A objectives.

INSTRUCTIONAL GUIDELINES

This first grade geometry unit emphasizes manipulative activities to familiarize the child with the geometric shapes and figures found in the environment.

Specific teaching directions are included in each module and it is suggested that an entire section be read through completely before beginning instruction.

Teacher Directed Activities

This section provides the teacher with introductory activities to be used with the class as a whole.

Individual and Small Group Activities

Following the introduction of the concepts, these activities provide the child with the opportunity to put his new knowledge to use.

Worksheets

This section includes sheets that may be duplicated for use by the student. These sheets give the child the opportunity to express his understanding of the concepts in written form.

Culmination

This section can be used to help you determine how well the students have achieved the objectives.

As each class differs in abilities, this geometry package is designed to provide the teacher with a selection of possible activities which she/he could adapt to the needs of her/his individual class.

A P P E N D I X C

Samples of

TEACHER EDUCATION MATHEMATICS COURSES

1978-79

MEMORIAL UNIVERSITY OF NEWFOUNDLAND, FACULTY OF EDUCATION

Mathematics 1150

A course for primary and elementary teachers emphasizing the Mathematical systems and topics in Finite Mathematics. Topics include Sets and Logic, Elementary Number Theory, Mathematical systems including Real Numbers, Probability and Matrices.

Mathematics 1151

A course in Geometry for primary and elementary teachers. Topics include Area; Volume; Compass and Straight-edge constructions of Plane Figures; Polyhedra; Teselations of space; Transformational Geometry introduced through the physical motions of slides, flips and turns leading to a study of Congruence, Similarity, and Symmetry; and a brief introduction to non-Euclidean Geometry.

Mathematics 2340 - Mathematics Programmes for the Primary and Lower Elementary Grades (F) & (W) (P, E)

A study of a variety of contemporary mathematics programmes both structured and non-structured. Such programmes as the Nuffield mathematics programme, project mathematics, activity-oriented programmes, and non-graded programmes will be studied as well as the particular programmes authorized for use in Newfoundland schools. Emphasis will also be placed on the research in children's learning of mathematics, particularly that of Piaget along with its implications for teaching.

Mathematics 2341 - Directing Learning Experiences in Mathematics for Children in Primary and Lower Elementary Grades (F) & (W) (P, E)

A variety of teaching techniques will be explored. Prospective teachers will be expected to explore, devise and demonstrate a variety of manipulative aids to be used in providing effective learning experiences in mathematics for all children. Some attention will also be given to diagnosing student difficulties and assessing student achievement.

UNIVERSITY OF NEW BRUNSWICK, FACULTY OF EDUCATION

Ed. CI 1414 - Orientation of Mathematics Education I

A term course to introduce students to the investigative and activity approaches in the learning of mathematics.

Ed. CI 1415 - Orientation to Mathematics Education II

A second term of mathematics for students wishing to follow up EDCI 1414.

Ed. CI 2414 - Elementary Mathematics I

An overview of the mathematics underlying the elementary school mathematics curriculum. Emphasis is on the study of the mathematical principles and procedures in the K-6 programme.

Ed. CI 2424 - Elementary Mathematics II

Further examination of the mathematics curriculum and related physical models for teaching mathematics at levels K-3.

Ed. CI 2425 - Elementary Mathematics III

Further examination of the mathematics curriculum and related physical models for teaching mathematics at level 2-5.

Ed. CI 2426 - Elementary Mathematics IV

Further examination of the mathematics curriculum and related physical models for teaching mathematics at level 4-6.

Ed. CI 3424 - Teaching Elementary Mathematics

An examination of strategies useful to teaching an elementary school mathematics programme. Emphasis is placed on examining a variety of physical aids, mathematical approaches and classroom techniques to aid student learning. For Mathematics Concentrators this is a pre-internship course; all other students should elect it in the 4th year.

Ed. CI 4404 - Contemporary Trends in Elementary Mathematics Education

A post-internship course primarily for elementary Mathematics Concentrators who wish to do further study of alternative methods and curricula for an elementary mathematics programme. If elected, only 3 hours may normally be taken in EDCI 4423 (5423) - Independent Study in Mathematics Education.

Ed. CI 4423/5423 - Independent Study in Mathematics Education

Primarily a reading and projects course in the mathematics curriculum of the public schools and the field of study affecting this curriculum. Work is in the student's area of interest. Enrolment is restricted to mathematics teachers and Mathematics Concentrators, who may earn not more than 6 credit hours through independent study.

Ed. CI 5404 - Problem Solving in the Teaching of Mathematics

A seminar course primarily for secondary students in mathematics education to investigate techniques useful in generating and solving mathematical problems, particularly as these relate to the mathematics curriculum.

Ed. CI 5405 - Special Topics in Mathematics Education

An examination of current and past literature relevant for the mathematics teacher. Examination of the psychological, sociological, and historical bases of mathematics education. Topics also include curricular study and remediation in mathematics K-12.

UNIVERSITY OF REGINA, FACULTY OF EDUCATION

Mathematics 218 - Introduction to Teaching of Elementary School Mathematics

Recent innovations in mathematics education examined with reference to the philosophy, goals and principles of learning in the discipline. Role of the teacher in mathematics curriculum planning and revision.

Mathematics 228 - Structure and Methodology of Mathematics for Elementary School Teachers

A sequel to EDMTH 218 - to be taken during the professional year. Topics: structure of mathematics and methodology related to primary/intermediate, Division III mathematics curriculum; recent innovations in mathematics education examined with reference to philosophy goals and principles of learning in the discipline; role of the teacher in mathematics curriculum planning and revision.

Mathematics 326 - Mathematics for the Elementary School Teacher

A workshop approach to the study of the methodology of elementary school mathematics.

Mathematics 336 - Curriculum and Instruction: Mathematics in the Elementary School

Understanding structure and discovery in mathematics. New approaches to structuring content and establishing strategies of teaching. Laboratory procedures mandatory.

THE UNIVERSITY OF ALBERTA, FACULTY OF EDUCATION

1. Elementary School Mathematics Education Courses

Ed. CI 216 - Curriculum and Instruction in Elementary School Mathematics (3 hours)

An introductory course in elementary school mathematics education designed to give prospective elementary teachers some competence in the mathematical concepts taught in the elementary school and to provide a repertoire of teaching strategies.

Ed. CI 316 - Laboratory Procedures and Materials Elementary School Mathematics (3 hours - lab)

This course meets once a week for three hours. Students will have experiences in laboratory activities which can be used as alternate strategies or methods to the more formalized instructional situation; build and use mathematical models and devices, and consider ways in which these materials can be effectively used with children; and become familiar with procedures by which instructional materials may be evaluated.

Ed. CI 317 - Diagnostic Teaching of Mathematics (3 hours)

This course provides the opportunity to examine curriculum and methods of instruction in mathematics for exceptional children. (At the present time, emphasis is on mentally retarded children.)

Ed. CI 416 - Instruction in Elementary School Mathematics (3 hours)

This course is designed to develop more fully the topics introduced in Ed. CI 216. The mathematical concepts that form the content of K-6 curricula are studied. Teaching and learning strategies are examined. Some experience with children in laboratory situations may be incorporated into the course.

Ed. CI 417 - Curriculum in Elementary School Mathematics (3 hours)

This course provides an opportunity to examine the curriculum by considering concrete aids, printed non-textual material, games and audio visual aids which can be used to present basic concepts, as well as those concepts which are supportive, complementary or supplementary to the basic curriculum. A laboratory approach is utilized for most large group sessions. Students are frequently involved in seminar sessions and a field experience component.

Ed. CI 516 - Program Development in Elementary School Mathematics (6 hours)

This course provides an opportunity to study the contributions of leading mathematics educators; to prepare, evaluate and revise curricular materials; to analyze research, and to pursue an indepth study of an area of interest and need.

Ed. CI 616 - Research in Mathematics Education (6 hours)

This course provides an opportunity for the student to become familiar with research in mathematics education and particularly with that which pertains to elementary school mathematics; to become proficient in initiating and carrying out projects for elementary schools which are designed to improve mathematics teaching and learning; and to learn to initiate and design research projects dealing with mathematics learning in elementary schools.

2. Elementary and Secondary

Ed. CI 448 - The Mathematics Curriculum K-12 (3 hours)

This course studies problems attendant to the development of a scope and sequence for the school mathematics curriculum. How such a curriculum is articulated and experiences arranged for various age levels of students is considered.